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TESTS OF DDT AND PYRETHRUM IN OIL SOLUTIONS AND IN EMULSIONS AGAINST THE EARWORM IN SWEET CORN

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Market gardeners in the important sweet-corn-growing sections of Illinois have not favorably considered the application of oil insecticides by the hand-injection method for control of the corn earworm (Heliothis armigera (Hbn.)). Furthermore, this method is too expensive for use on canning corn. Therefore, in 1943 preliminary tests were conducted with oil-water emulsions containing pyrethrum, in an effort to find a cheaper mixture that could be rapidly and effectively applied to the ears externally as an atomized spray. These tests did not give a high degree of control, apparently because of the poor physical characteristics of the emulsions. In an effort to improve them, further tests with pyrethrum (0.2 percent pyrethrins) or technical DDT (1-trichloro-2,2-bis(p-chlorophenyl)ethane), in oil solution and in emulsions, were conducted in 1944 in corn planted for canning or for market at Gibson City and Collinsville, Ill. The solutions and the emulsions were applied both by injection and atomization.

Experimental Methods

The emulsions were mixed by hand in small quantities. This method of mixing is laborious and inefficient, but out of a large number of trials, seven satisfactory fast-breaking emulsions and eight stable emulsions[1/] were obtained.

Injections were made with a small hand injector manufactured for the purpose, at the rate of 0.6 ml. per ear regardless of the type of material. The insecticide was atomized with a small paint spray gun, pressure being supplied from a cylinder of carbon dioxide. The oil solutions and fast-breaking emulsions were atomized at 30 to 35 pounds pressure, and the heavier stable emulsions at 40 to 45 pounds. Enough material was applied to wet the silks and upper parts of the ears with little or no run-off.

1/ The term "stable emulsion" is used in this paper to refer to mixtures that did not separate noticeably. In one instance, at least, a mixture that appeared to be stable when stirred with a glass rod was relatively fast-breaking when made later with an electric mixer.

From 25 to 50 ears were treated with each material in each test. The treatments were applied to some ears before the silks had wilted and to others immediately afterward. The results were determined when the corn reached the marketing stage.

Results

Table 1 shows the data on control of the earworm with the different materials when applied by atomization and by injection. The number of ears damaged represents those having more than 1½-inch tip injury. Comparative amounts of injury to tips of the ears, as indicated by prevention of kernel development, are shown in table 2 for three series of tests conducted at one location. DDT residues resulting from the application of the insecticide in an oil solution, a fast-breaking emulsion, and a stable emulsion were determined by the Division of Insecticide Investigations and are given in table 3.

Table 1.--Effectiveness of DDT and pyrethrum in oil solution and in emulsions applied by atomization onto or injection into silks for control of the corn earworm in sweet corn

Insecticide	Accessory material	Formula No.	Tests		Average ears undamaged		Average ears damaged		Average larvae per ear	
			Atomized	Injected	Atomized	Injected	Atomized	Injected	Atomized	Injected
			Number	Number	Percent	Percent	Percent	Percent	Number	Number
			Oil Solution							
DDT 2%	Superla No. 13[1]		3	--	92.7	--	2.0	--	0.17	--
Pyrethrins 0.2%	do.		4	4	79.4	69.5	4.4	8.0	.22	0.21
			Fast-breaking Emulsions							
DDT 2%	Xylene 2.5% + Triton B-1956[2] 1%									
	2 applications		1	--	94.7	--	5.3	--	0	--
	1 application	69	4	3	45.0	72.4	13.6	8.2	.30	.22
	Cyclohexanone 2% + Amine 220[3] 0.5% + Bayol[1] 2.5%	37-D-2	1	1	50.0	61.1	8.8	11.1	.24	.33
	Xylene 2.5% + Triton B-1956 0.5% + Bayol 2%	70	3	3	37.2	62.9	15.4	8.0	.60	.36
1%	Same	70A	3	2	28.1	61.0	11.1	6.5	.52	.41
0.5%	Same except Bayol 1%	70E-1	1	1	15.4	57.1	3.8	4.4	.62	.11

1/ Highly refined mineral oils (Superla No. 13, 120-130 seconds Saybolt; Bayol, 80-90 seconds Saybolt).

2/ A phthalic glyceryl alkyd.

3/ An amine type compound containing a tertiary amino group. The aqueous solutions are alkaline in character.

Table 1.—(Continued)

Insecticide	Accessory material	Formula No.	Tests		Average ears undamaged		Average ears damaged		Average larvae per ear	
			Atomized	Injected	Atomized	Injected	Atomized	Injected	Atomized	Injected
			Number	Number	Percent	Percent	Percent	Percent	Number	Number
Pyrethrins 0.2%	Amine 220 0.75% + Bayol 2%	23E	2	2	17.5	15.7	23.8	24.0	0.70	0.62
	Triton B-1956 1% + Bayol 2.5%	22B	2	2	8.6	21.2	35.4	22.5	1.40	1.11
			Stable Emulsions							
DDT 2%	Xylene 2.5% + Triton B-1956 0.1% + Superla #13 (oil) 10%	71	1	—	72.7	—	4.5	—	.18	—
	Same except oil 5%	71A	1	—	65.0	—	10.0	—	.35	—
	Same except oil 2.5%	71B	1	—	50.0	—	25.0	—	.25	—
	Xylene 2.5% + Triton B-1956 1% + oil 10%	72	1	—	86.7	—	6.7	—	.13	—
	Same except oil 5%	72A	1	—	47.1	—	17.6	—	.35	—
	Same except oil 2.5%	72B	1	—	85.0	—	0	—	.20	—
	Pyrophyllite 2% + Amine 220 1.75% + Bayol 2.5%	37G	3	2	34.5	64.6	9.4	10.4	.61	.42
Pyrethrins 0.2%	Amine 220 0.75% + Bayol 5%	23D	2	3	12.5	46.8	29.6	22.6	.75	.62
Check (untreated)			9		6.7		49.4		1.22	

Table 2.--Average percentages of completely filled ears and average loss to tips of unfilled ears in treated and untreated samples. Gibson City, Ill. August 25, 29, and September 4, 1944

Insecticide	Accessory material	Formula No.	Tests		Completely filled ears		Tip loss in unfilled ears	
			Atomized	Injected	Atomized	Injected	Atomized	Injected
			Number	Number	Percent	Percent	Inches	Inches
			Oil Solutions					
Pyrethrins 0.2%	Superla No. 13		2	2	16.4	1.7	1.25	1.24
DDT 2%	do		3	--	33.8	--	1.18	--
			Fast-breaking Emulsions					
Pyrethrins 0.2%	Amine 220 0.75% + Bayol 2%	23E	1	1	33.3	14.3	.72	.81
	Triton B-1956 1% + Bayol 2.5%	22B	2	2	16.8	18.7	.72	.87
DDT 2%	Xylene 2.5% + Triton B-1956 1%	69	2	2	14.7	8.5	.81	.81
	Xylene 2.5% + Triton B-1956 0.5% + Bayol 2%	70	2	2	28.1	9.0	.76	.87
	Cyclohexanone 2% + Amine 220 0.5% + Bayol 2.5%	37-D-2	--	1	--	19.4	--	1.32
DDT 1%	Same as formula 70	70A	2	1	24.6	6.5	.72	.84
			Stable Emulsions					
Pyrethrins 0.2%	Amine 220 0.75% + Bayol 5%	23D	1	2	21.4	5.9	.73	.96
DDT 2%	Pyrophyllite 2% + Bayol 2.5% + Amine 220 0.75%	37G	2	1	22.4	2.7	.78	.85
Check (untreated)			3		20.8		.77	

Table 3.--DDT residues resulting from injection and atomization of 2 percent of DDT in oil solution and in emulsions

Formulation	Method of application	Husked ears		Husk plus silk	
		Chlorine	DDT	Chlorine	DDT
		Mg. per ear		Mg. per ear	
Oil solution	Atomized	0.085	0.27	--	--
Emulsions:					
Formula 69	Injected	.146	.88	0.0134	0.134
Formula 71B	Injected	.336	2.78	.195	1.95
	Atomized	.080	.22	.771	7.71
Check (untreated)		.056	0	not run	

1/ Quantities of DDT probably are slightly high since they were determined from the organic chlorine content of the samples uncorrected for chlorine in nontreated material.

Discussion

As shown in table 1, DDT in mineral oil or in an emulsion gave much better control than did pyrethrum. DDT in one emulsion which did not contain oil was somewhat more efficient when injected, or with two applications atomized, than pyrethrum in straight mineral oil. Although the plots were subjected to showers of rain from 2 to 8 days after the materials were applied, good control was obtained by atomization of several of the oil emulsions containing DDT, whereas none of the emulsions containing pyrethrum offered any promise. It cannot be considered, however, that the best type of emulsion or best possible method of application has yet been employed.

A part of the damage in the ears treated by atomization with DDT apparently resulted from reinfestation by the corn earworm, since most of the larvae observed in the ears at harvest were small. An undetermined amount of the damage in one test was due to the fall armyworm (Laphygma frugiperda (A. and S.)). This armyworm and larger earworms entering through the sides of the husks appeared to cause more injury to ears treated by injection than to those treated by atomization. Considering the above points, DDT in an emulsion or oil solution applied by atomization seems very promising for control of the earworm. These tests were preliminary in character, however, and no recommendations for practical farm use can yet be made. Further information is needed on the best mixtures to use, on their toxicity to the plants, on the quantities of DDT residue present on the portions of the plants actually eaten by man or animals, and on the toxicity hazard of these residues.

All but one of the formulations containing either DDT or pyrethrum caused some reduction in development of tip kernels when applied by injection. The tip-kernel loss was much less when the mixtures were applied by atomization although on an occasional ear the damage was relatively severe. The loss due to lack of tip development in the ears treated with emulsions applied by atomization was not appreciably greater than the loss in untreated ears. Neither did the emulsions appear to affect kernel development in the ears having fresh silks at the time of application any more than they did ears with wilted silks. In addition to preventing complete development of the ear tips, injection of these emulsions caused slight to severe rotting of the ears. When atomized onto the ear tips, only one of the emulsions caused any rotting of the ears.

Slight yellowing occurred on plants atomized with DDT and pyrethrum both in straight oil and in emulsions. In most cases this was not thought to affect development of the ears in any way. The most severe burning was found in those plots atomized with emulsions containing the solvents xylene and cyclohexanone. Emulsifier Amine 220 may have contributed to the damage. The plot that received a double treatment of the emulsion containing xylene as a solvent and Triton B-1956 as the emulsifier was very severely burned. Excessive amounts of straight oil accumulating behind leaf sheaths or points of attachment of the ears caused burning at the points of contact. Neither DDT nor pyrethrum of itself seemed to damage the plants.